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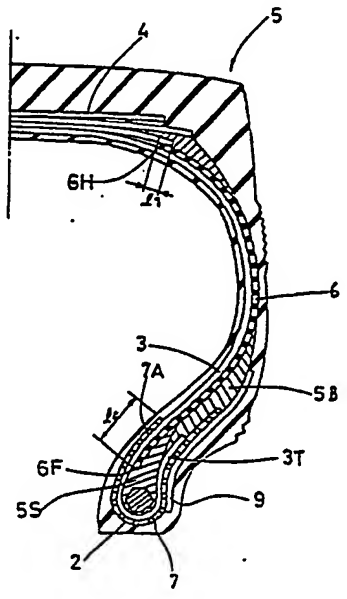
(54) RADIAL TIRE FOR HIGH LOAD WITH IMPROVED VIBRATION DAMPING PERFORMANCE.

(57) A radial tire for high load, wherein vibration damping performance is improved by arranging adjacent to a carcass ply in a radial arrangement reinforced plies of carcass cords consisting of fiber cords which have both radial ends thereof lapped over a certain width on a belt ply and a reinforced ply at a bead portion and which are arranged at a bias angle of 30 to 90° to the radial direction of a tire.



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RADIAL TYRE FOR HIGH LOAD WITH IMPROVED VIBRATION DAMPING PERFORMANCE

The present invention relates to a radial tyre for high load suitable for material handling vehicles, and construction vehicles.

Hitherto, the so called crossply or bias ply tyre has been used for high load condition industrial vehicles, constructions vehicles and the like, but recently, radial tyres having a carcass of steel cords have become most popular because of excellent ride comfort and good wear resistance.

However, such radial tyres have a smaller vertical spring coefficient and less damping and so especially when used on fork-lifts which continually turn, start and stop much rolling and pitching of the vehicle occurs. Also when the tyres run over projections on the road the vehicle body rolls constantly. This becomes a real problem, if the steel tyres with conventional structure are used on the industrial vehicles, such as the

fork-lift or very high working vehicles, because they become a factor allowing and causing vibration of the vehicle, its mast or crane. In comparison radial tyres applied to passenger cars do not suffer from this problem.

The inventors studied ways of reinforcing the carcass of such radial tyres, particularly the portions in the tyre sidewalls which bend and investigated means by which the vibration damping performance could be improved, and the object of the present invention is to meet these objectives.

The present invention provides a radial tyre for high loads comprising a carcass ply of steel cords laid at an angle of 70 to 90 degrees to the circumferential direction of the tyre and both edges of which are folded back around bead cores to be secured thereto; a belt layer of steel cord plies arranged outside the crown of the carcass with the steel cords at small angles to the circumferential direction of the tyre; bead apexes between the carcass and the folded portions thereof

each of which extend into a sidewall of the tyre from the upper part of each bead core and having gradually decreasing thickness characterised by in each sidewall a carcass cord reinforcing layer on adjacent the carcass ply which extend to the bead from the edge portion of the belt layer. The invention is illustrated by way of example in the drawings which are as follows:-

In Fig.1. radial tyres for high loads has a carcass ply 3 having both edges folded back around respective bead cores 2 and secured thereto. Also provided are a belt layer 4, bead apexes 5 and two carcass cord reinforcing layers 6 on the outside of the carcass one at either side of the tyre which extend to the beads from both edge portions of the belt layer 4.

Each bead is reinforced by a bead reinforcing layer 7, which is disposed on the outside (in this embodiment) of the carcass 3 so as to surround the bead core 2, and each carcass cord reinforcing layer 6 overlaps the belt layer 4 and the bead

reinforcing layer 7 in both edge portions thereof in the radial direction of the tyre.

The carcass cord reinforcing layers 6 reinforce the sidewalls of the tyre, and, for that, high elastic cords such as aromatic polyamide fibre cords are preferably used, although organic fibre cords such as nylon, polyester and/or rayon are also usable. The fibre cords are laid at a bias angle between 30 and 90 degrees to the radial direction of the tyre, thereby increasing the lateral rigidity of the tyre sidewalls by interacting with the carcass 3 of which the cords are laid in the radial direction.

The upper edge 6H of the carcass cord reinforcing layer 6 is positioned under the edge portion of the belt layer 4 so as to partly overlap with the belt layer 4. The upper edges 6H are accordingly secured between the belt layer 4 and the carcass 3, as shown.

Fig.2, shows an embodiment in which the carcass cord reinforcing layers 6 are disposed on the inside of the carcass ply 3. The lower edge 6F of

the carcass cord reinforcing layer 6 is interposed between the bead reinforcing layer 7 and the carcass 3. The upper edge 6H is then overlapped only indirectly with the belt layer 4.

The embodiment of Fig.3 has two carcass cord reinforcing layers 6A and 6B in each sidewall which are disposed on both the inside and the outside of the carcass ply 3.

The result is that the transmission of force from the tread to the tyre sidewall is improved by the reinforcing layers 6, and the vibration damping performance of the tyre is also improved. The sidewalls are reinforced by the radial cord carcass 3 and the carcass reinforcing layers 6 in which the cords are arranged at a bias, and as a result, the vertical coefficient is increased and generation of rolling and/or pitching of a vehicle is reduced even when there is an unbalance of loads between the left and right wheels.

The lower edge 6F of the carcass cord reinforcing layer 6 is, as shown in the figures, terminated in

a position above the bead core 2 and axially inside the bead core 2 -- not on the folded portion (3T) side of the carcass ply 3. It overlaps the folded part 7A of the bead reinforcing layer 7 indirectly through the carcass ply 3 (see Fig.1) and is not itself secured around the bead core 2. The bead reinforcing layer 7 extends into the sidewall beyond the folded portion 3T of the carcass 3, although optically the folded portion 3T can be terminated in a position higher than the upper edge of the bead reinforcing layer 7.

By overlapping the lower edge part 6F of the carcass cord reinforcing layer 6 of the bias arrangements with the bead reinforcing layer 7, the tyre load transmitted between the tyre beads and the wheel is dispersed more widely than in conventional structures not only in the radial direction but also in the circumferential direction of the tyre, and also the vibration damping performance is improved. Furthermore the generation of roll and pitch in a vehicle is lessened.

Preferably, the breadth 11 of the overlap of the carcass cord reinforcing layer 6 with the belt layer 4 and the breadth 12 of the overlap of the carcass cord reinforcing layer 6 with the bead reinforcing layer 7 are more than 5mm. In this embodiment, they are 20 mm and 30 mm, respectively. If they are less than 5 mm, the load can not be transmitted smoothly and the vibration damping performance is not improved.

Under ordinary conditions, the carcass cord reinforcing layer 6 preferably comprises only one ply of cords if the cords are aromatic polyamide fibre cords, but if the cords are nylon fibre cords or the like it is preferably formed by two or more plies arranged crosswise.

In the present invention, the bead apexes 5 are disposed radially outside and adjacent to the above-mentioned carcass cords. For the bead apexes 5, there is preferably used a two-component apex comprising a stiffener made of hard rubber having JIS A hardness of 75 to 90 degrees and a buffer

made of soft rubber having JIS A hardness of 45 to 65 degrees. As a matter of course, there can be used a single-component apex made of hard rubber. The upper edge thereof extends to the range of 20 to 60 % of the cross-sectional height of the tyre, and provided the functions of reinforcing the beads and the sidewalls and increasing the lateral and vertical spring coefficient of the tyre.

In this embodiment, a further reinforcing layer 9, which extends toward the sidewall beyond the bead reinforcing layer 7, is disposed outside each bead reinforcing layer 7.

As mentioned above, in the present invention, the steel radial tyre is provided with carcass cord reinforcing layers having a bias arrangement which are disposed adjacent to the outside of the radial cords of the carcass extending from the beads to the two edges of the belt layer, whereby the lateral and vertical spring coefficients of the tyre are greater than the conventional steel tyre. Accordingly, unstable states due to rolling and the

pitching are greatly prevented, and at the same time, damping performance of the vibration for the mast of fork-lifts, and vibration of the top of the high reach vehicles such as truck cranes and the like is effectively improved.

By way of example tyres of size 700.R12 were made for trial in accordance with the structure shown in Fig.1 and the specifications shown in Table 1, and tested for various tyre characteristics such as rolling, damping coefficient and spring coefficient. As reference for comparison, bias tyres, steel textile tyres, and steel radial tyres were made in accordance with the prior art and the specifications shown in Table 1. The measurements of the characteristics shown in Table 1 were performed under the conditions that the air pressure was 7.0 kgf/cm (for bias tyre) and 9.0 kgf/cm (for radial tyre) and the advantages of the invention can be clearly seen.

TABLE 1

	Ref. 1	Ref.2	Ref. 3	Ref. 4	Ex. 1
Carcass					
Structure	Bias	Radial	Radial	Radial	Radial
No. of ply	6	4	1	1	1
Cord material	Nylon 1260d/2	Nylon 1500d/2	Steel 7x4/0.175	Steel 7x4/0.175	Steel 7x4/0.175
Cord angle (°)	36	90	55	90	90
Belt layer					
No. of ply	1	3	3	3	3
Cord material	Nylon 840d/2	Steel 3/0.20+6/0.38	Steel 3/0.20+6/0.38	Steel 3/0.20+6/0.38	Steel 3/0.20+6/0.38
Cord angle (°)	36	67/16/16	67/16/16	67/16/16	67/16/16
Cord reinforcing layer					
No. of ply				2	2
Cord material				Nylon 1260d/2	Nylon 1260d/2
Cord angle (to the radial direction)				70°	70°
Overlap (Belt layer)				0	20 mm
Overlap (Bead reinforcing layer)				0	30 mm
Bead apex			hard/soft two-compo.	hard/soft two-compo.	hard/soft two-compo.
JIS A hardness (°)	86	86	86/60	86/60	86/60
No. of rollings to convergence *1	8.7	9.2	10.5	10.3	9.5
Convergence time (sec) *1	9.9	10.4	12.3	12.0	10.7
Damping coefficient *1	100	96	74	81	100
Feeling test *2	4+	3+	3-	2-	4+
Vertical spring coefficient (kgf/mm)	79	98	91	93	96
Lateral spring coefficient (kgf/mm)	28	29	28	29	31

*1: The number of rollings to convergence, the convergence time and the damping coefficient were measured with a accelerometer attached to the mast of a forklift when a wheel on one side run over a protrusion on a loaded condition. The damping coefficient is indicated by an index based on an assumption that the result of the reference 1 is 100, wherein the larger the value, the better the performance.

*2: In the feeling test, ride comfort upon actual running was evaluated by a feeling five point method. The larger the value, the better the performance. The point less than 3 means a unsatisfactory result.

CLAIMS

1. A radial tyre for high loads comprising a carcass ply (3) of steel cords laid at an angle of 80 to 90 degrees to the circumferential direction of the tyre both edges (3T) of which are folded back around bead cores to be secured thereto, a belt layer (4) in which steel cord plies are arranged outside the crown of the carcass ply (3) with the steel cords at a small angle to the circumferential direction of the tyre, bead apexes (5) between the carcass ply (3) and the folded portions (3T) thereof, each of which extend into the sidewalls of the tyre from the upper part of each bead core (2) and having gradually decreasing thickness characterised by in each sidewall a carcass cord reinforcing layer (6) adjacent the carcass ply (3) which extend to the beads from both edge portions of the belt layer.

2. A radial tyre according to claim 1, wherein the carcass cord reinforcing layers are of fibre cords.

3. A radial tyre according to claim 1, characterised in that the beads are reinforced with bead reinforcing layers disposed along the carcass so as to surround the bead cores, and each carcass cord reinforcing layer overlaps with the belt layer and the bead reinforcing layer in both edge portions in the radial direction of the tyre.

FIG. 1

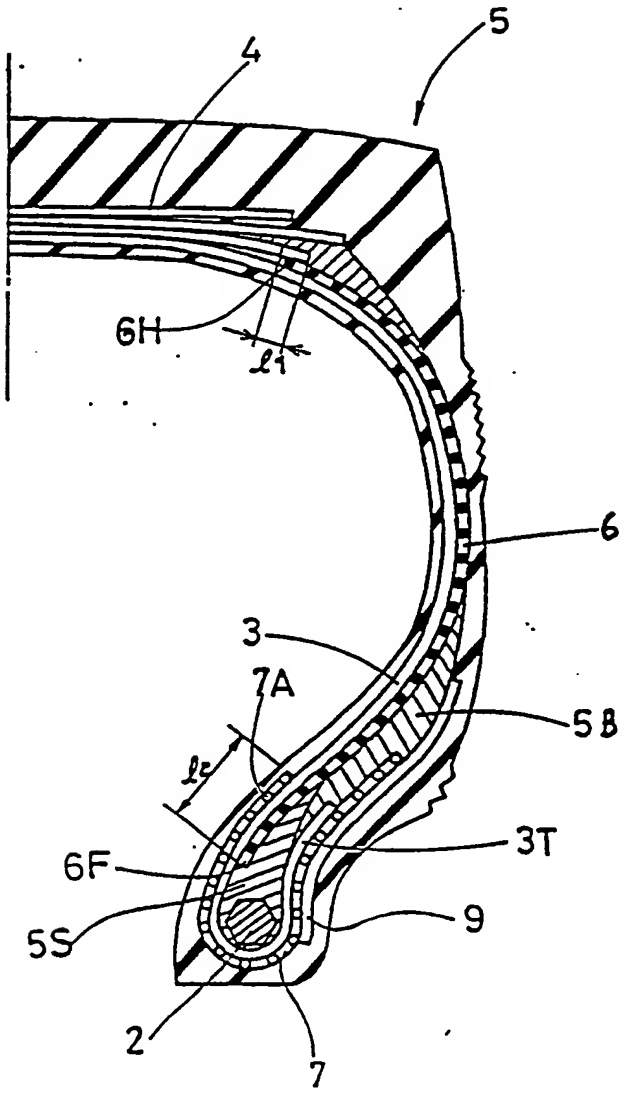

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FIG. 2

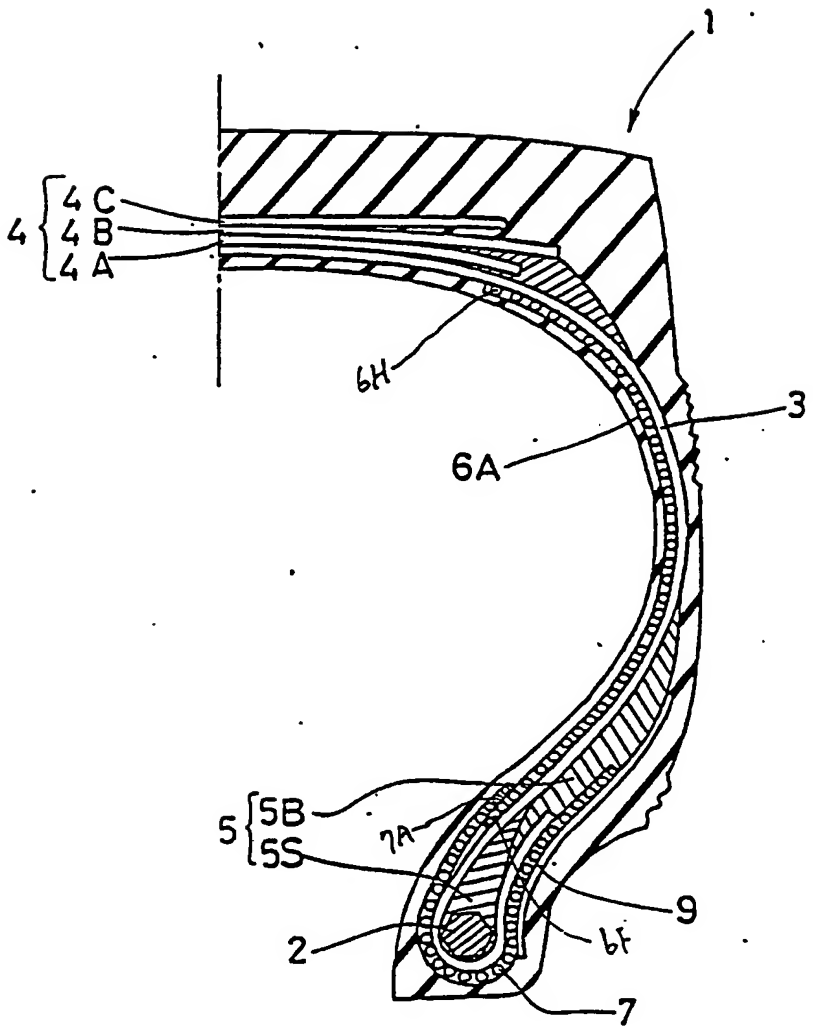

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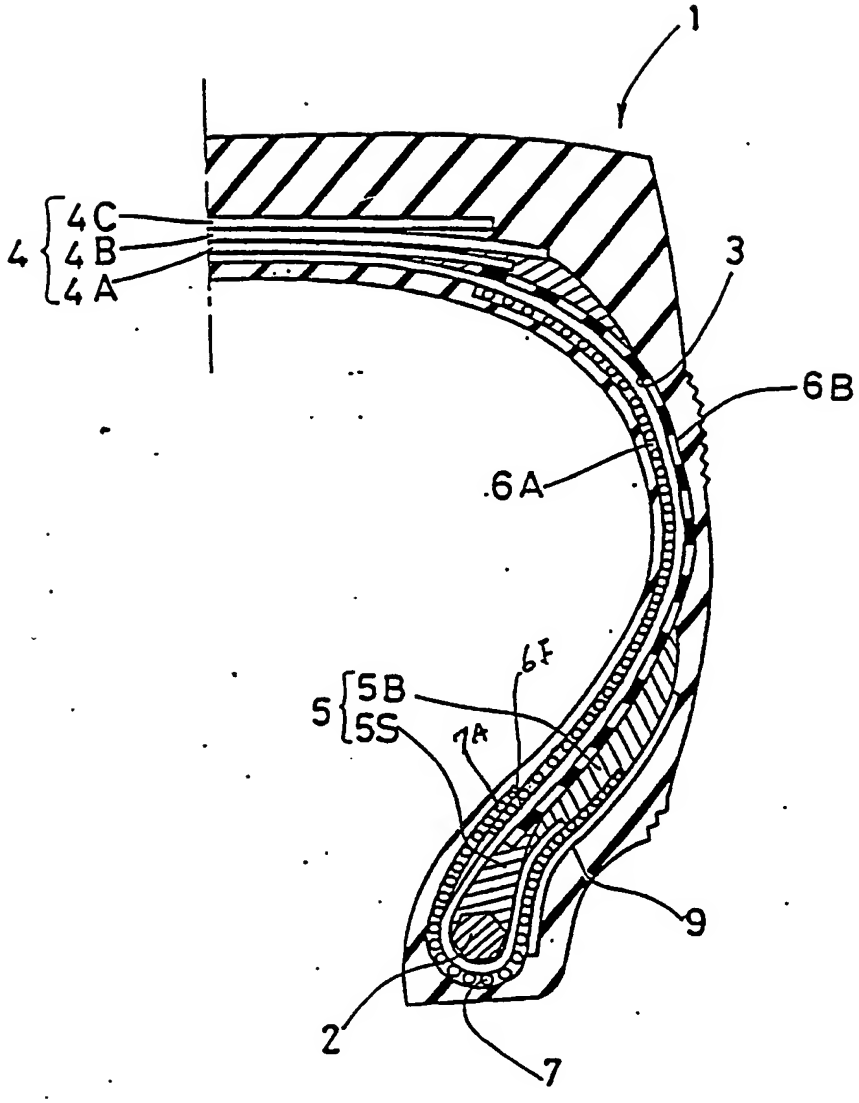
FIG. 3



FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

column 17, line 13, Fig. 6
& GB, A, 1565574 & US, A, 4436130

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers..... because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers..... because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.